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REPLICA INSPECTION OF LAKEVIEW UNITS 5 & 6 TURBINE LOOP PIPE COMPONENTS

Report No. 90-329-K

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ABSTRACT

Towards the end of Lakeview Rehabilitation on Units 5 & 6, 36 welds from the high pressure (HP) and intermediate (IP) turbine loop pipe system were examined by surface replication. Twelve of these welds were found to contain varying degrees of Type IV creep damage and required either spool piece removal or full weld repairs. The use of surface replication to examine other loop pipe welds at Lakeview (particularly Units 3 & 4) is strongly recommended during future rehabilitation exercises. Loop pipe welds in Units 5 & 6 that were not inspected during this operation should be inspected within two years.

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EXECUTIVE SUMMARY

REPLICA INSPECTION OF LAKEVIEW, UNITS 5 & 6 TURBINE LOOP PIPE COMPONENTS

I. Thompson and M.A. Clark
Metallurgy Section

On August 23, 1990 during the rehabilitation of high pressure (HP) and intermediate pressure (IP) turbine loop pipe components at Lakeview Generating Station, Units 5 & 6, magnetic particle inspection (MPI) detected severe macro cracks in two weldments. The cracks were inspected by Metallurgical Research using surface replication techniques and were found to originate from severe Type IV creep damage. Full weld repairs were required to remove this damage.

Following these results a request was made to inspect the remaining turbine loop pipe welds by replication. Time and manpower constraints allowed only those welds most likely to develop Type IV creep damage to be replicated. A total of 36 welds were replicated of which 12 were found to contain varying degrees of Type IV creep damage. All of these welds required either spool piece replacements or full weld repairs.

It is strongly recommended that replica inspections of turbine loop pipe welds become a planned exercise during future Lakeview Rehabilitation (particularly Units 3 & 4). A large number of welds in Units 5 & 6 were not inspected and should be within the next 2 years. Creep damaged spool pieces have been sent to Metallurgical Research for a more detailed examination. The results will be published in a separate report.

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TO Mr. M.D. Larmour
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H14 A01

REPLICA INSPECTION OF LAKEVIEW, UNITS 5 & 6, TURBINE LOOP PIPE COMPONENTS

INTRODUCTION

On August 23, 1990 during the rehabilitation of high pressure (HP) and intermediate pressure (IP) turbine loop pipe components at Lakeview Generating Station, Units 5 & 6, magnetic particle inspection (MPI) conducted by GEC/HOWDEN detected severe macro cracks in two weldments (see Appendix III). Upon request from GEC/HOWDEN these damaged weldments were inspected by Metallurgical Research using replication techniques. The cracks originated from severe Type IV creep damage and, as such, required full weld repairs.

Following these results a request for replication of welds that had been previously inspected by GEC/HOWDEN using MPI and ultrasonic techniques (UT) was made by CPSD Metallurgy to OHRD. There are 105 welds in the Unit 5 & 6 loop pipe system that GEC/HOWDEN was responsible for. Because of time constraints, it was impossible to inspect all of these welds by replication, therefore only those most likely to contain creep damage were chosen for replication. This amounted to an additional 34 welds. Another 4 "new" HP welds were macroetched only, to ensure the old heat affected zone (HAZ) had been entirely removed. For each weld, a maximum of only 2 areas were replicated concentrating on the HAZs. Normal Research practise is to replicate 4 areas per weld.

A more detailed description of the replication technique and the creep damage classification system used for welds, is given in Appendix I.

RESULTS

The results of the replica investigation for the 36 welds are presented in tabular form in Appendix II. The locations of these 36 welds are shown schematically in Figures 1-5. A total of 79 areas were replicated to evaluate these welds. Of these 36, 12 welds were found to contain

creep damage that was significant enough to warrant a full weld repair or spool piece replacement. These welds are:

Unit 5 H.P. East Loop Pipe to Steam Chest on the South side of the Turbine (Jt# 5TLL1) - This weld was found to contain severe Type IV level D creep damage (see Fig. 6) oriented circumferentially in the Steam Chest (SC) HAZ, extending for 10 cm on the South side of the pipe. Upon examination of the spool piece, profuse Type IV level A creep damage was also found to extend to the North side of the pipe, again in the SC HAZ.

Unit 5 H.P. West Loop Pipe to Steam Chest on the South side of the Turbine (Jt# 5BLR1) - This weld was found to contain severe Type IV level D creep damage oriented circumferentially in the SC HAZ, extending for 10 cm on the South side of the pipe. This weld was also found to contain profuse Type I level C creep damage near the SC fusion line, again at the South location.

Unit 5 East Reheat Intercept Pipe to North Reheat Steam Chest (Jt# 5IPM1) - This weld was found to contain a dense distribution of axial Type III level C and Type IV level A creep damage in the intercept pipe HAZ at the bottom location.

Unit 5 H.P. East Loop Pipe to Steam Chest on the North side of the Turbine (JT# 5TLR1) - This weld contains extremely isolated Type IV Level A creep damage in the Steam Chest HAZ at both the North and South replica locations. Isolated Type III level B and extremely isolated Type IV level A was also found in the pipe HAZ at the South replica location.

Unit 5 H.P. West Loop Pipe to Steam Chest on the North side of the Turbine (JT# 5BLL1) - This weld contains a dense distribution of Type IV level A/B creep damage in the Steam Chest HAZ at the North replica location and extremely isolated Type IV level A in the South replica location. Profuse Type III level C and isolated Type IV level A was also found in the pipe HAZ at the South replica location.

Unit 5 H.P. Upper Loop Pipe Terminal Weld to Turbine on the South side of the Turbine (JT# 5TLL5) - This weld contains a dense distribution of Type III level C and Type IV level B/A (see Fig. 8) in the Flange HAZ throughout the entire extrados replica location. The I.D. replica location was also found to contain isolated areas of Type III level B and less dense Type IV level A in the Flange HAZ as well.

Unit 5 H.P. Upper Loop Pipe Terminal Weld to Turbine on the North side of the Turbine (JT# 5TLR5) - The extrados replica site was found to contain Type IV level A in the Flange HAZ along the entire replica. No creep damage was found at the intrados replica location.

Unit 6 H.P. Upper Loop Pipe Terminal Weld to Turbine on the South side of Turbine (JT# 6TLR5) - The extrados replica site was found to contain a dense distribution of Type III level B/C and a lower density of Type IV level A compared to it's Unit 5 equivalent, all located in the Flange HAZ. The intrados replica site was found to contain isolated areas of Type IV level A in the Flange HAZ as well.

Unit 6 H.P. Upper Loop Pipe Terminal Weld to Turbine on the North side of the Turbine (JT# 6TLL5) - The extrados replica site was found to contain isolated areas of Type III level B/C and a dense distribution of Type IV level A creep along 1/3 of the replica location. The intrados replica location was also found to contain isolated areas of Type III B/C and Type IV level A. All creep damage was confined to the Flange HAZ.

Unit 6 H.P. 'Y' Piece to Steam Chest East Leg on the South side of the Turbine (Jt# 6HPM5) - This weld was found to contain Type IV level B/C/D (see Fig. 7) circumferential creep damage in the girth weld 'Y' piece HAZ at both the east and top replica locations. In addition to this damage a significant shop weld repair was also discovered. This shop weld repair begins at the east side of the pipe and extends for 180° over the top of the pipe to the west side. The repair extends to a maximum distance of 8 cm into the parent metal, with creep damage level A/B extending to the maximum repair distance along the repair fusion line to the parent metal.

Unit 6 H.P. 'Y' Piece to Steam Chest West Leg on the South side of the Turbine (Jt# 6HPM4) - Following a macro etch this weld was found to contain a shop weld repair of approximately the same size and location as the east leg described above. Circumferential macro cracks were also found on the east side of the pipe in the Type IV region, again similar to the east leg. Replicas revealed Type III & IV level A creep damage in the girth weld 'Y' piece HAZ at the Top replica location. The East replica location was also found to contain Type III level A/B to one side of the replica and Type IV level A along the entire replica.

Unit 6 H.P. East Loop Pipe Terminal Weld to G.I.E.S./G.V. (Jt# 6BLL1) - This weld was found to contain Type IV level A creep damage in the Steam Chest HAZ at both north and SOUTH replica locations. The north replica location was also found to contain Type III level B in the Steam Chest as well.

A qualitative ranking of damage severity in the weldments is presented in Tables I, II and III. A ranking of 1 is considered to be the most severe while a ranking of 4 is considered the minimum Type IV, damage. Ranking of 5 means the weld contains other types of creep damage and a ranking of 6 contains no creep damage.

With the exception of Jt#'s 5TLL1, 6HPM4 and 6HPM5 all welds are to be repaired by machining down to the weld root followed by a full weld repair according to Howden Canada's welding procedure# 458-1. To ensure that Type IV creep damage was completely removed selected welds

were replicated at the weld root prior to filling in the excavated area. These welds are 5BLR1, 5TLL5, 5TLR5, 6BLL1*, 6TLL5* and 6TLR5*.

Welds 5TLL1, 6HPM4 and 6HPM5 are to be repaired with replacement spool pieces. Welding of new spools was performed according to the same procedure. The creep damaged spools were sent to OHRD to further characterize damage. The results of these findings will be published in a later report.

DISCUSSION

The investigation has discovered a particulary high incidence of type IV creep damage in the U5, U6 turbine piping; 12 damaged out of 36 inspected welds. Over 200 high energy line welds have been inspected at LVGS following the Unit 3 & 4 'T' piece failures[1]. Only 6 confirmed incidences of Type IV creep damage have been discovered. The higher frequency in turbine piping could originate with either the different alloy, 1/2Cr-1/2Mo-1/4V, being more susceptible than P11 or P22 or with higher stresses in the relatively more rigid loop pipe system. Obviously more attention needs to be given to turbine piping systems in future rehabilitation inspections.

The Unit 5 turbine piping appeared to be more susceptible to damage than U6. The number of creep damaged welds was greater in Unit 5 than Unit 6 (7 versus 5 respectively). If the Unit 6 'Y' piece welds are disregarded (as their damage was nucleated by a shop weld repair due to a deficient casting), then the difference in damage occurrence between units becomes significant. This differing susceptibility becomes even more apparent when the degree of creep damage is compared between the two units (Table III). With the exception of the 'Y' piece failures, most of the Unit 6 failures have less advanced creep damage in the same locations as the corresponding Unit 5 equivalent welds. The reason for this difference (assuming the stresses are identical) is probably the number of operating hours in the two units. To date, Unit 5 has approximately 87000 hours while Unit 6 has 77000 hours. Referring to Table III the most significant difference in creep damage between equivalent welds was 5TLL1 and 6BLL1 (Type IV Level D versus isolated Type IV Level A respectively). This suggests that Type IV damage progression from Level A to D requires 10000 hours or 2 years for this particular material under typical operating conditions.

The number of documented Type IV failures are rare[1-7]. However, when hours to failure have been recorded, most failures have occurred within 90 000 hours. One example is Lakeview Units 3 & 4 Type IV main steam line 'T' piece failures which occurred in March 1989 with approximately 88 000 hours at the time of failure[1].

The ramification of these results is that turbine welds containing 1/2Cr-1/2Mo-1/4V with more than 80 000 hours of service are particularly susceptible to Type IV creep damage. Lakeview Units 3 & 4 are of particular concern as their turbine loop pipe system is identical to Units 5 & 6 and they have operated for more than 90 000 hours.

* this work is still pending

In 1987 a variety of high temperature components were inspected by surface replication at Lakeview Unit 4. Included in this inspection were 2 loop pipe welds that are susceptible to creep damage, based on the Unit 5 & 6 experience. These welds are the Upper Loop Pipe to North side of the Turbine casing and the West Leg 'Y' piece to the South Steam Chest. Both of these welds were found to contain no creep damage after 84 000 hours of operation[9]. At that time, only one area was replicated per weld so that, potentially, damage could have been undetected.

Although the U5 & U6 welds chosen for replication were suspected to be the most likely to contain Type IV creep damage, there are still an additional 65 that have not been inspected. With 30 % of the welds inspected containing creep damage, there is a strong possibility that there are more damaged welds in this system. Even the welds that were inspected had only 2 areas per weld replicated instead of the usual 4. This increases the possibility of missing localized creep damage in welds that were replicated. Both of these deficiencies in the procedure were caused by time and manpower constraints. If this exercise is to continue in future rehabilitations at Lakeview both of these constraints must be addressed.

CONCLUSIONS AND RECOMMENDATIONS

A total of 36 welds were inspected using surface replication techniques. Of these 36, 12 were found to contain varying degrees of Type IV creep damage and required full repairs.

1) Based on the amount of creep damage found in the Unit 5 & 6 Loop Pipe system it is strongly recommended that planned inspections of loop pipes by surface replication in other Lakeview units be incorporated into the rehabilitation project. Units 3 & 4 are particularly suspect and selected welds should be inspected at the next available outage.

2) A large number of loop pipe welds were not inspected in Units 5 & 6. Within the next 2 years most of these welds should be inspected as well.

3) The 10000 operating hour difference between Units 5 & 6 suggests that Type IV creep damage may not progress as rapidly as current thinking suggests (about 1 year). Unit 6 welds that have repaired equivalent welds on Unit 5 should be monitored on a yearly basis to further characterize this behaviour.

FUTURE RESEARCH WORK

A more precise method of quantifying early type IV creep damage, including both cavity density and extent around the pipe, needs to be developed. The spool pieces removed from U5 & U6 should provide valuable data in this regard; a detailed proposal will be generated following their examination.

ACKNOWLEDGEMENTS

The field and laboratory replication work was performed by Messrs. A. Cervoni, S. Nixon, B. Longboat and A. Ceranic. The contributions of Mr. Cervoni for field coordination was greatly appreciated. SEM examination of selected replicas was performed by Mr. F.W. Smith. Dr. H.J. Westwood's assistance in assessing damaged welds was also appreciated.

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Table I - Qualitative ranking of damage severity in Unit 5 Loop Pipe Welds

RANKING	WELD JT'	DESCRIPTION OF DAMAGE
1	5TLL1	Type IV Level D - 10 cm crack one loc'n
1	5BLR1	Type IV Level D - 10 cm crack one loc'n
2	5TLL5	Type IV A/B - dense both replica loc'ns
2	5BLL1	Type IV A/B - dense both replica loc'ns
3	5TLR1	Type IV A - isolated, two loc'ns
3.5	5IPM1	Type IV A & Type III C - one loc'n
4	5TLR5	Type IV A - one loc'n

Table II - Qualitative Ranking of Damage Severity in Unit 6 Loop Pipes

RANKING	WELD JT'	DAMAGE DESCRIPTION
1.5	6HPM5	Type IV C/D - on repair area
1.5	6HPM4	Type IV C/D - on repair area
2	6TLL5	Type IV A - dense, both loc'ns
2	6TLR5	Type IV A - dense, both loc'ns
3	6BLL1	Type IV A - isolated one loc'n

Table III - A Qualitative damage comparison of Units 5 & 6 Equivalent Welds

RANKING	U5 WELD JT#	U6 WELD JT#	RANKING
1	5TLL1	6BLL1	4
1	5BLR1	6TLR1	6
2	5TLL5	6TLR5	2
2	5BLL1	6TLL1	5
3	5TLR1	6BLR1	6
4	5TLR5	6TLL5	2

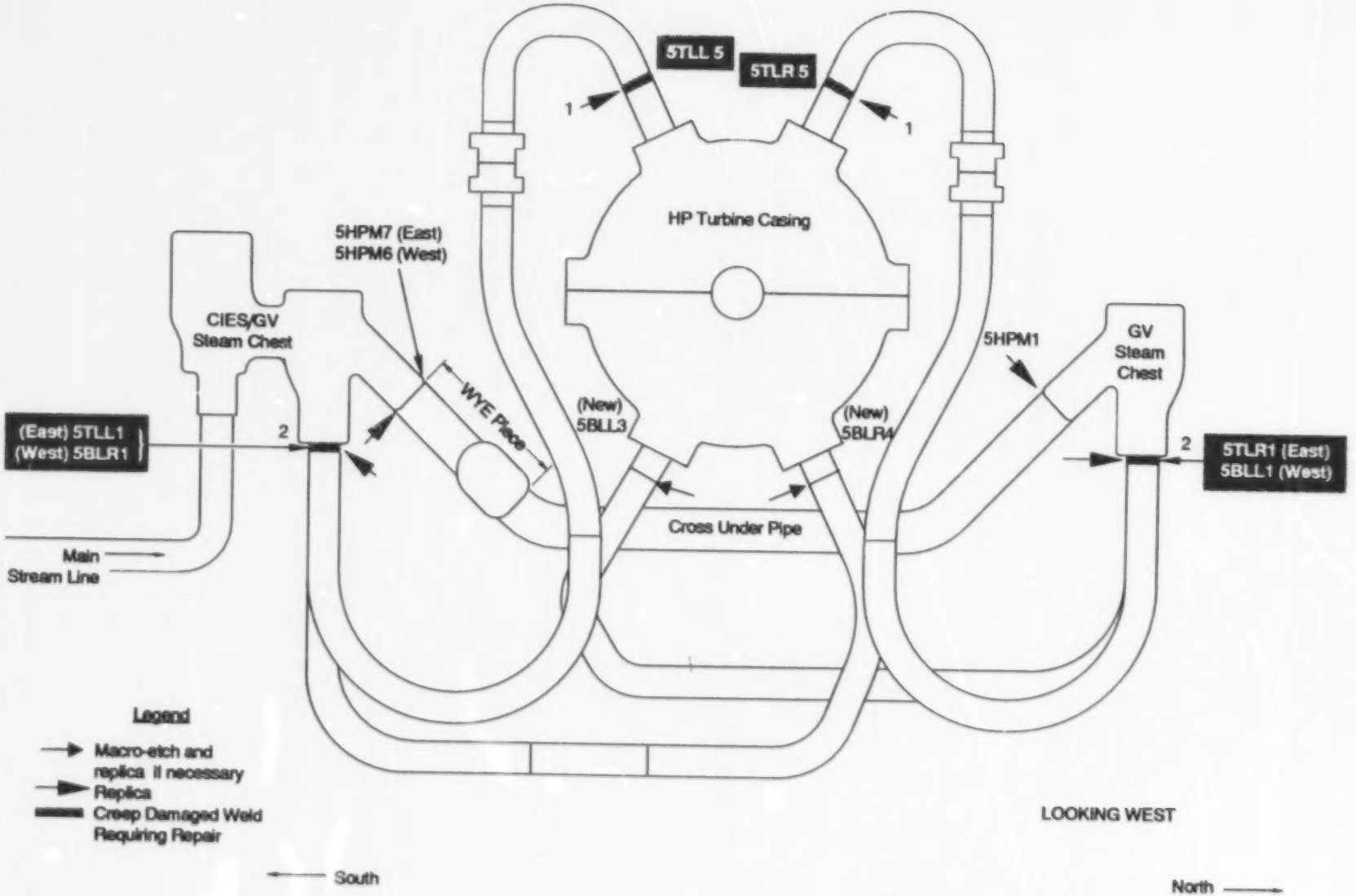

FIGURE 1

HP TURBINE HIGH TEMPERATURE PIPES - UNIT 5

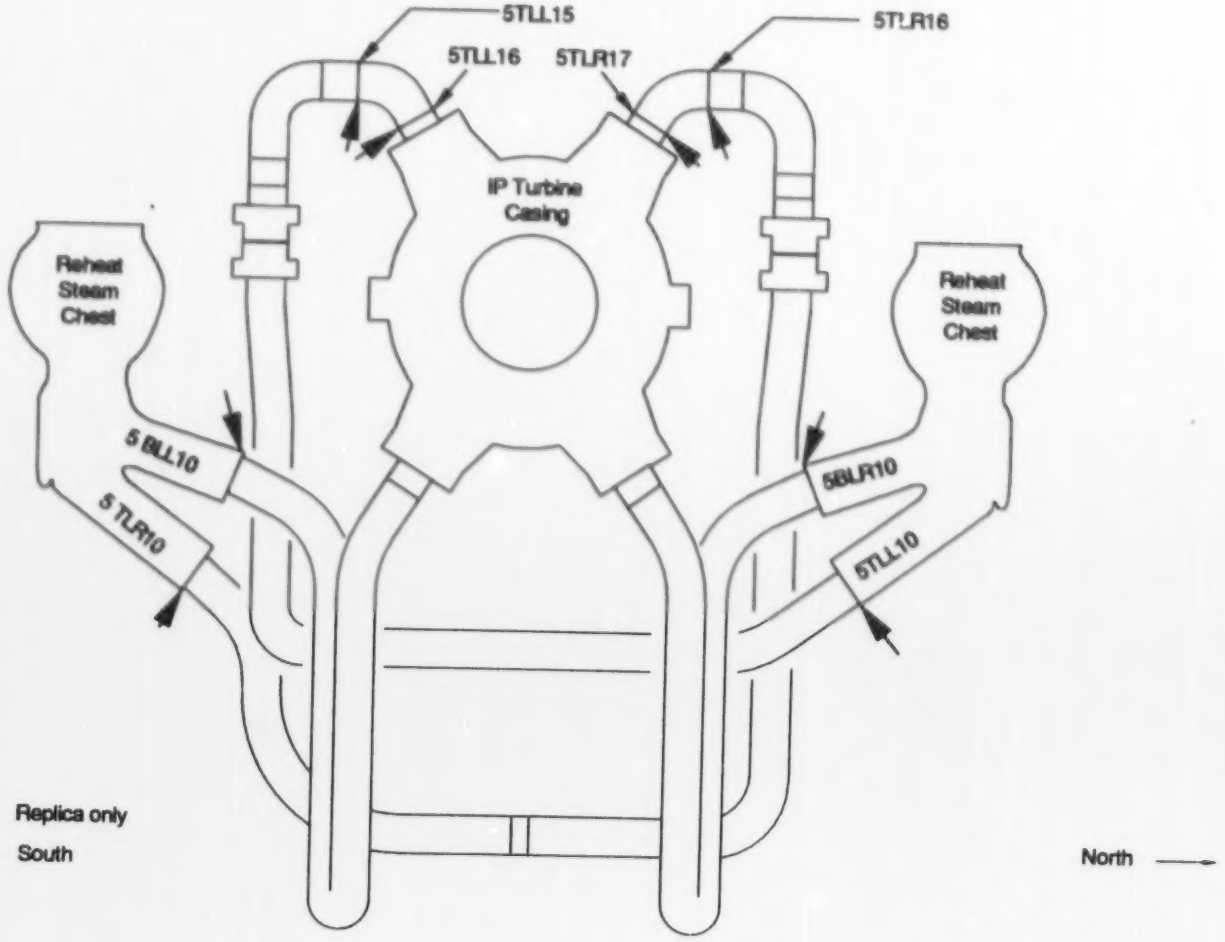

FIGURE 2

IP TURBINE HIGH TEMPERATURE PIPES - UNIT 5

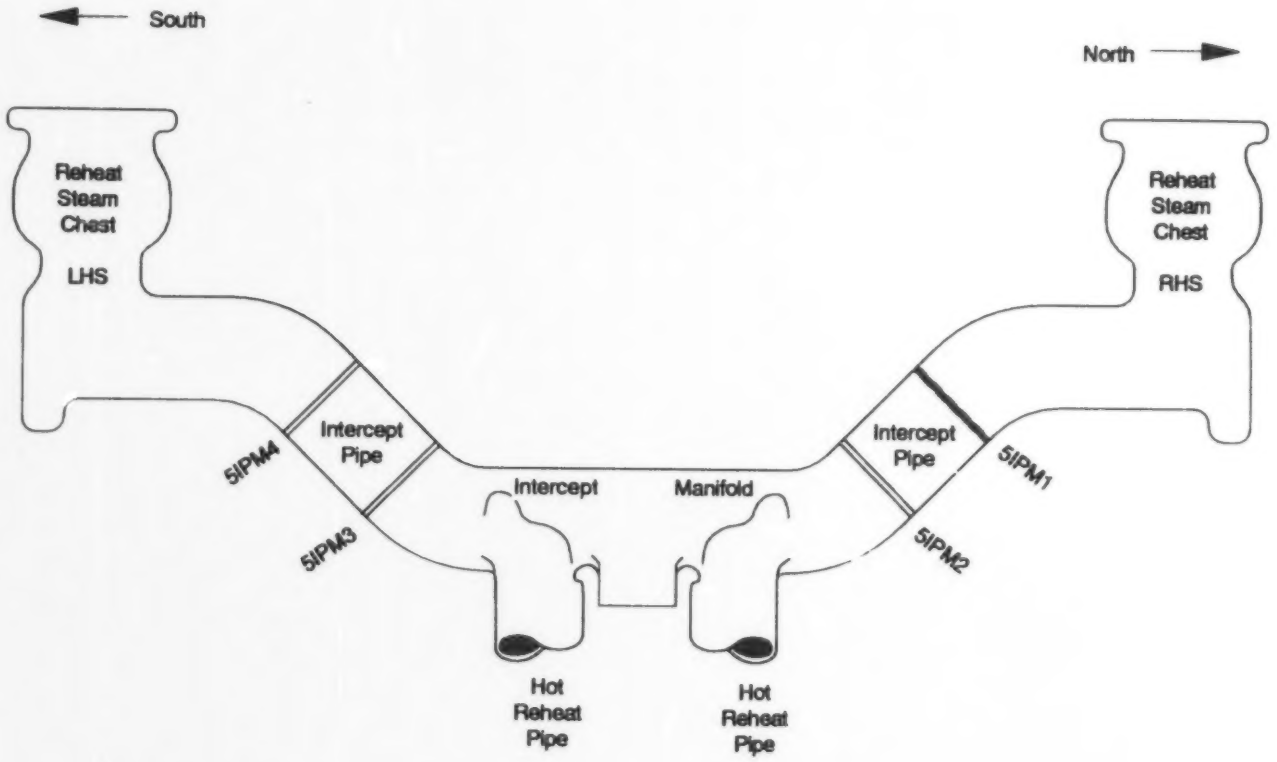

FIGURE 3

REHEAT INTERCEPT PIPES -UNIT 5

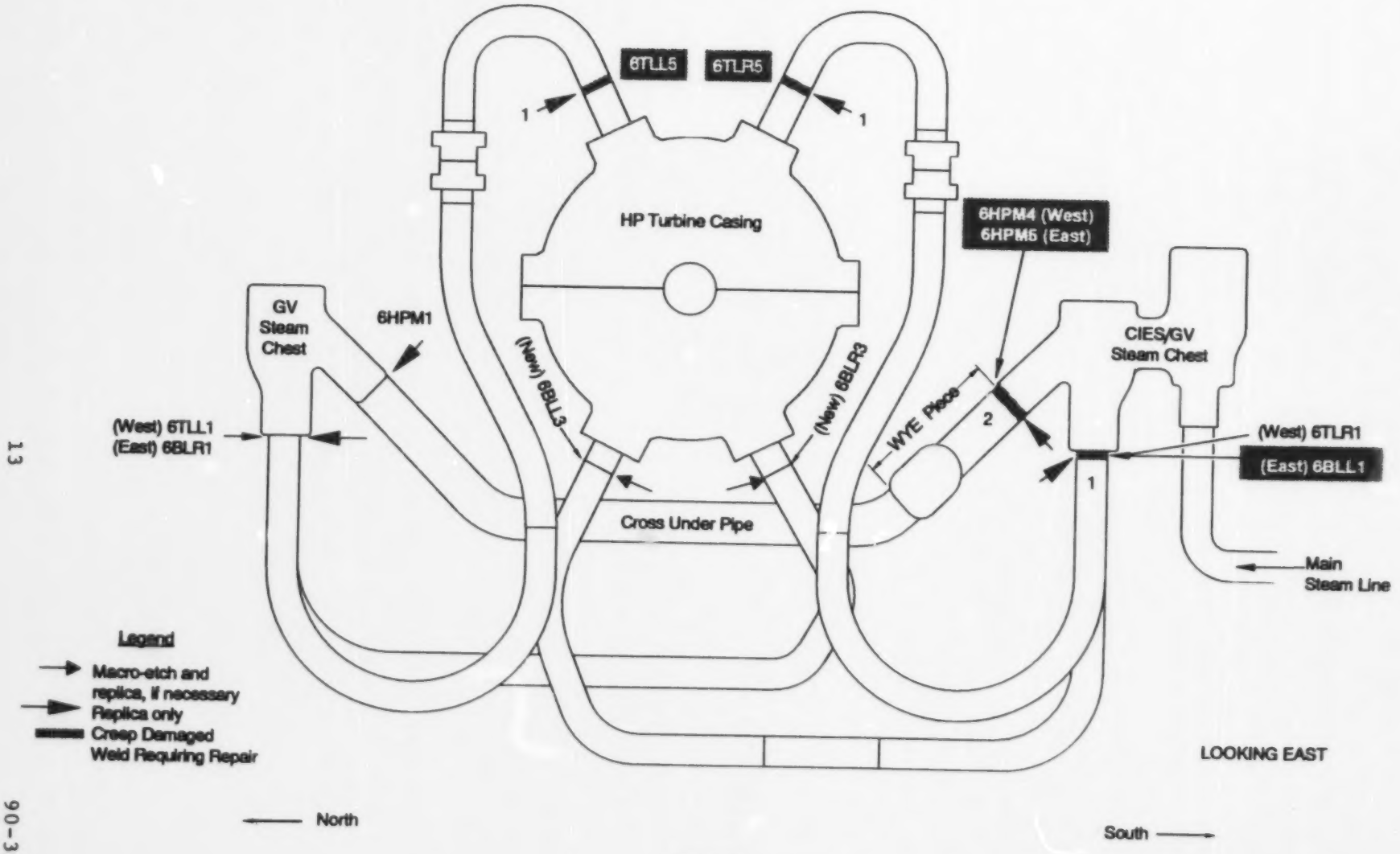

FIGURE 4

HP TURBINE HIGH TEMPERATURE PIPES -UNIT 6

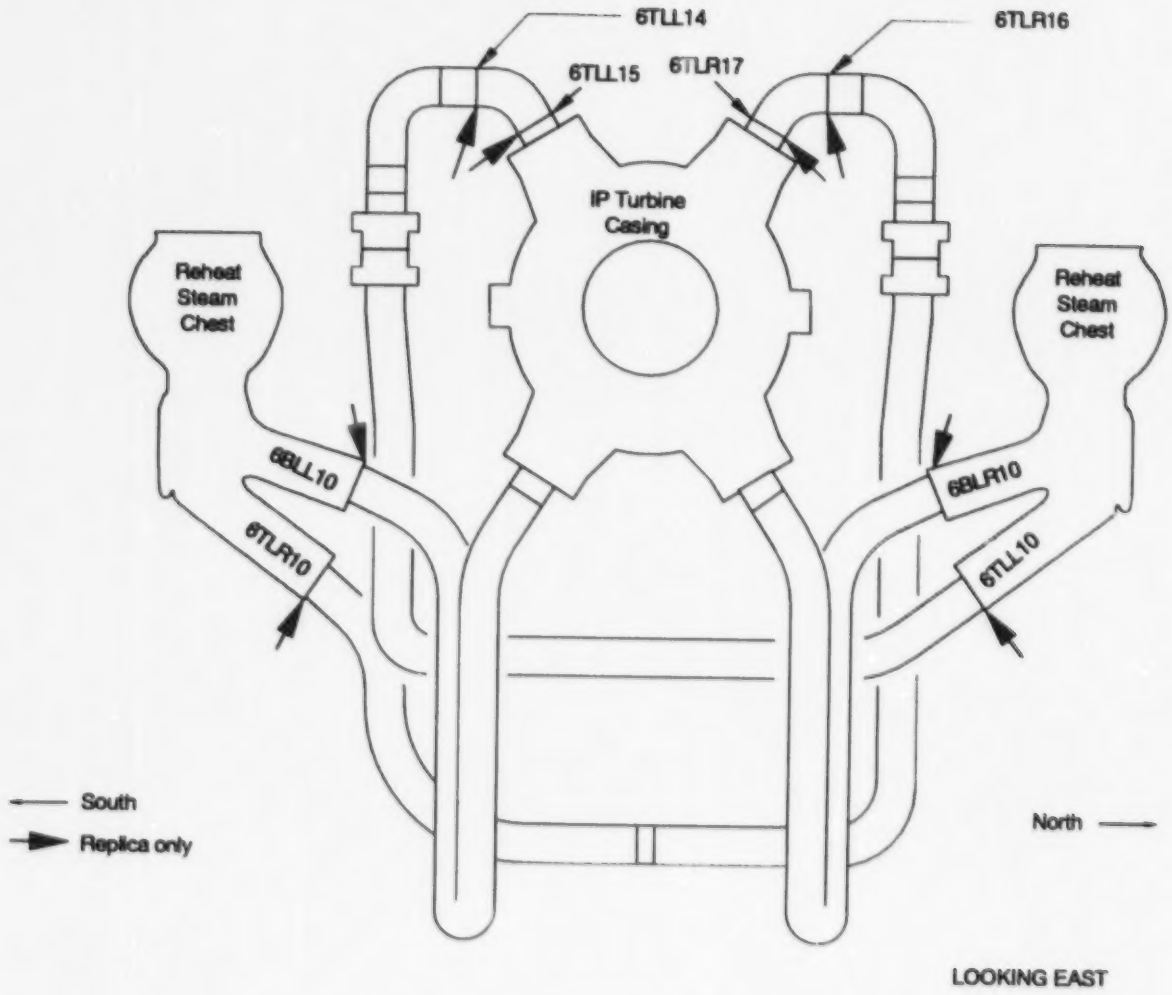

FIGURE 5

IP TURBINE HIGH TEMPERATURE PIPES
- UNIT 6

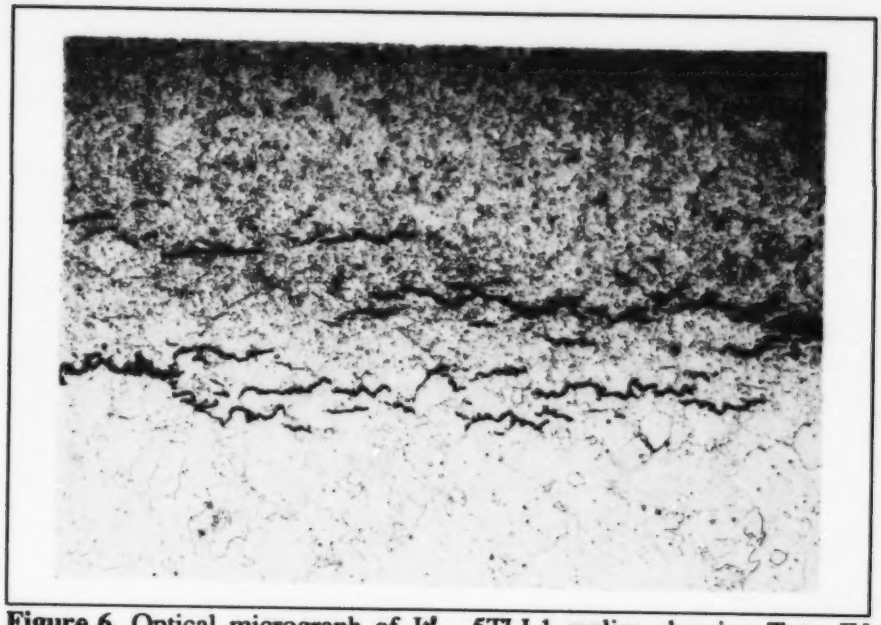

Figure 6. Optical micrograph of Jt' - 5TLL1 replica showing Type IV level D creep damage in SC HAZ. (mag = x50)

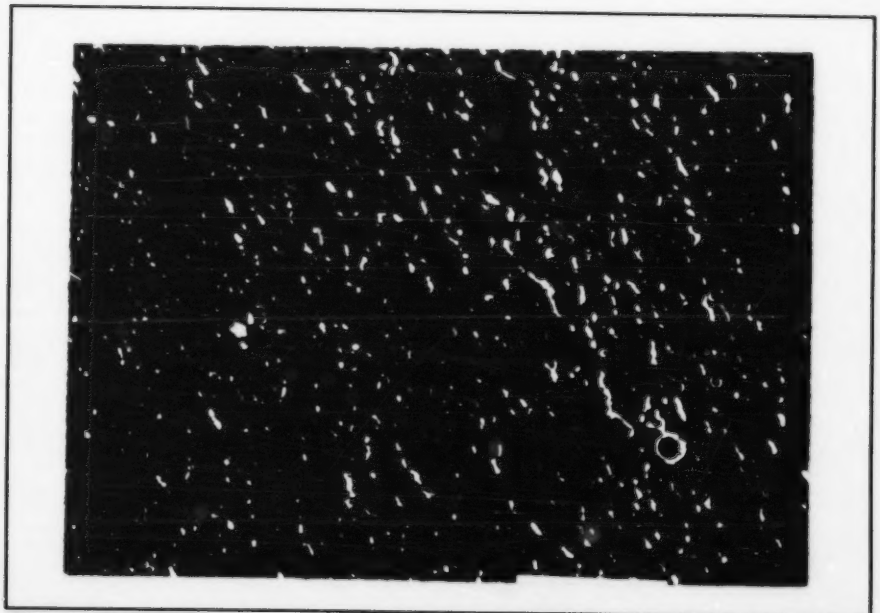

Figure 7. SEM micrograph of Jt' - 6HPM5 replica, showing dense Type IV Level C/B creep damage in 'Y' piece HAZ. The "white" areas are cavities and microcracks. (mag = x220)

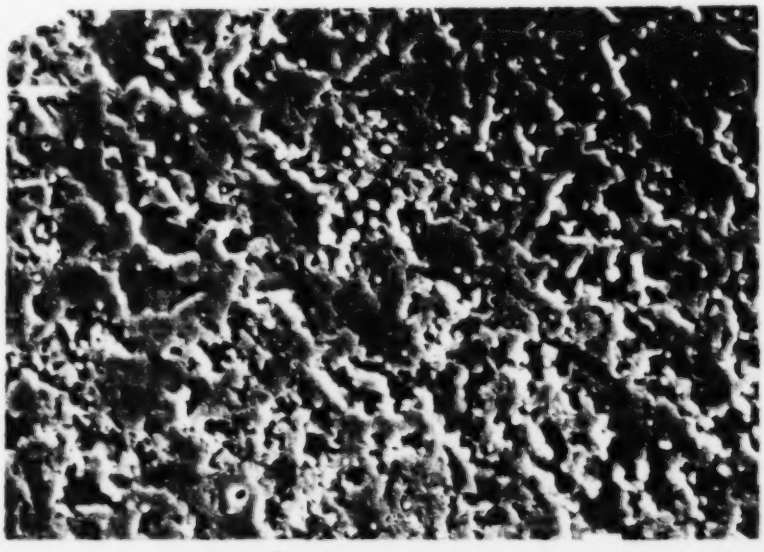

Figure 8. SEM micrograph of Jt' - 5TLL5 replica, showing Type IV Level A creep damage in flange HAZ. (mag = x540)

APPENDIX I

REPLICATION TECHNIQUE AND CREEP DAMAGE CLASSIFICATION

SURFACE REPLICATION

Replication is a nondestructive test that involves in situ polishing and etching, in order that a "fingerprint" of the metal's structure may be recorded on a plastic (acetate) film. Replicas are examined by optical microscopy and scanning electron microscopy (SEM) at OHRD. Replicas provide information on the metal's basic microstructure and the extent of any defects such as creep cavities, microcracks and other forms of cracking. Replication is the only known nondestructive technique that can detect the early stages of creep damage.

The present method used to examine a weld involves, taking replicas at four quadrants essentially selected at random to whatever stresses are in the pipe. For a typical loop pipe (22 cm OD), replicas can only inspect a maximum of 30 % of the total weld length. For this investigation a maximum of only two quadrants were inspected comprising 15 % of the weld length.

CLASSIFICATION OF CREEP DAMAGE IN WELDMENTS

Classification of creep damage in weldments has been broken down into two categories. The first is based on the location of damage in the weldment microstructure and the second is based on the severity of the damage. The location of damage is based on a German system[2] which classifies the damage as Type I,II,III, & IV and is shown in Figure I-1. Type I is failure occurring in the weld metal; Type II initiates in the weld metal and runs into the HAZ; Type III is in the coarse grained part of the HAZ adjacent to the fusion line; Type IV is in the region between the fine grain and partially transformed region of the HAZ[2]. The severity of damage is assigned either Level A,B,C or D and is shown in Figure I-2[2]. Level A represents isolated cavities, Level B represents oriented cavities, Level C represents linked cavities (microcracks) and Level D represents macrocracks.

Types I & II creep failure are relatively rare and have been mostly confined to longitudinal seam welds fabricated by submerged arc welds[2]. Within Ontario Hydro, longitudinal seam welds are not present in high energy pipe work and therefore this form of creep damage is of little concern.

Type III creep damage will generally nucleate at the surface of the weldment and progress through the various levels at a relatively slow rate (about 2 years per level). Therefore weldments containing this type of damage can be left in service until the latter stages with little concern of catastrophic failure.

Type IV creep damage begins as profuse but very fine cavitation that can rapidly develop into a major crack, perhaps within one year. Furthermore there is evidence to suggest that Type IV can be nucleated subsurface[1]. Thus Type IV damage detected by surface replication may be at

a much more advanced stage below the surface of the pipe. For these reasons Type IV damage is considered to be unmanageable and the only solution is a full weld repair.

The Level A,B,C & D damage severity system[7] which was originally developed for Type III, is the most common method for describing the degree of creep damage progression. Through the course of this and other studies, this method has been found deficient in accurately describing the early stages of Type IV Level A creep damage in terms of cavity density and total area covered. This has led to the creation of additional qualitative terminology in order to better describe the damage. These terms are a temporary solution until a more advanced classification system is developed.

Dense - implies that 1 or more creep cavities were observed per grain plus cavitation was found to occur throughout the entire length of the replica.

Isolated - implies that cavitation was found in less than 50 % of the replica (approx.).

Extremely Isolated - implies that cavitation was found in less than 25 % of the replica. Usually low cavity density is observed as well (ie less than 1 cavity per 5 grains).

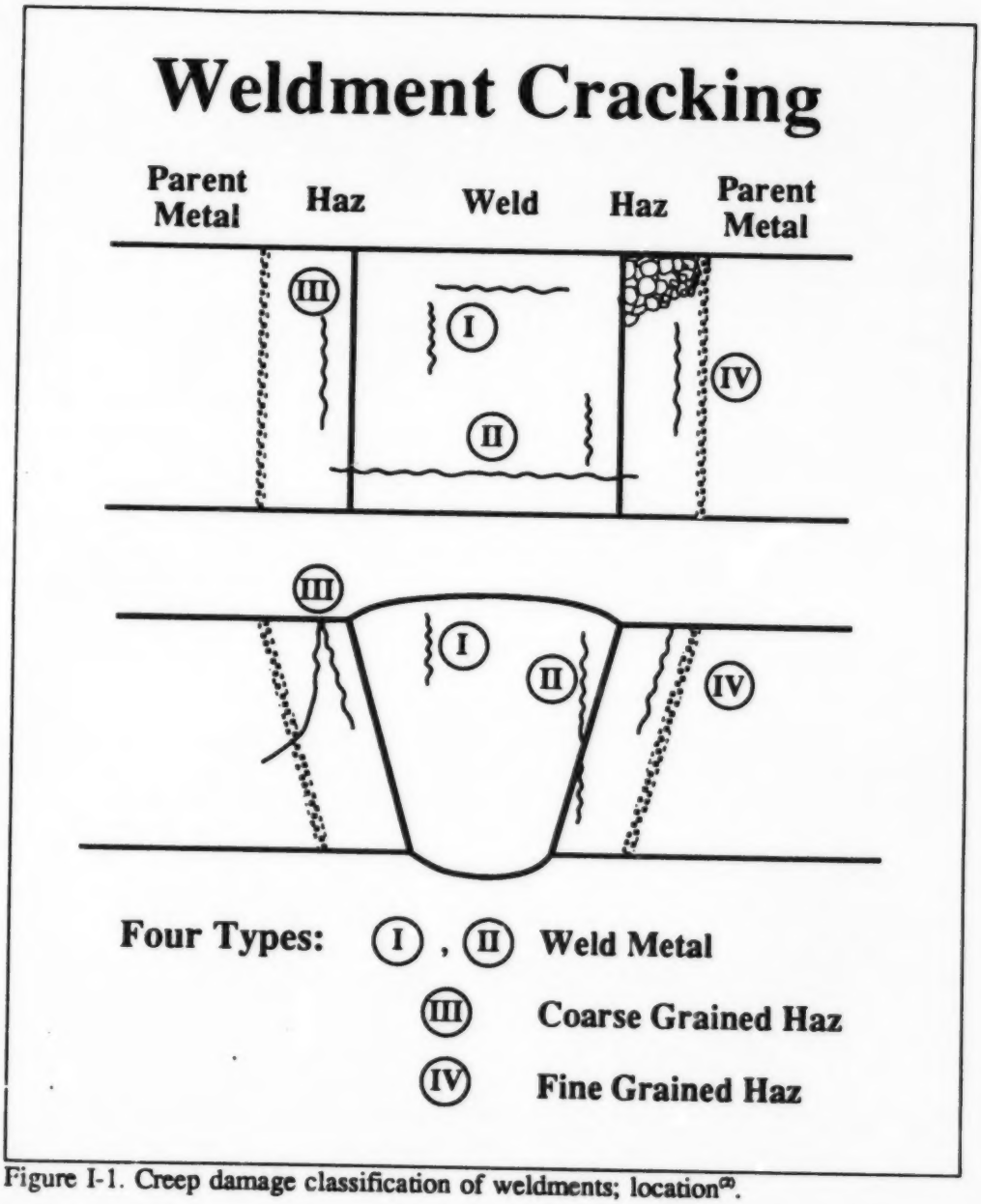

Figure I-1. Creep damage classification of weldments; location[20].

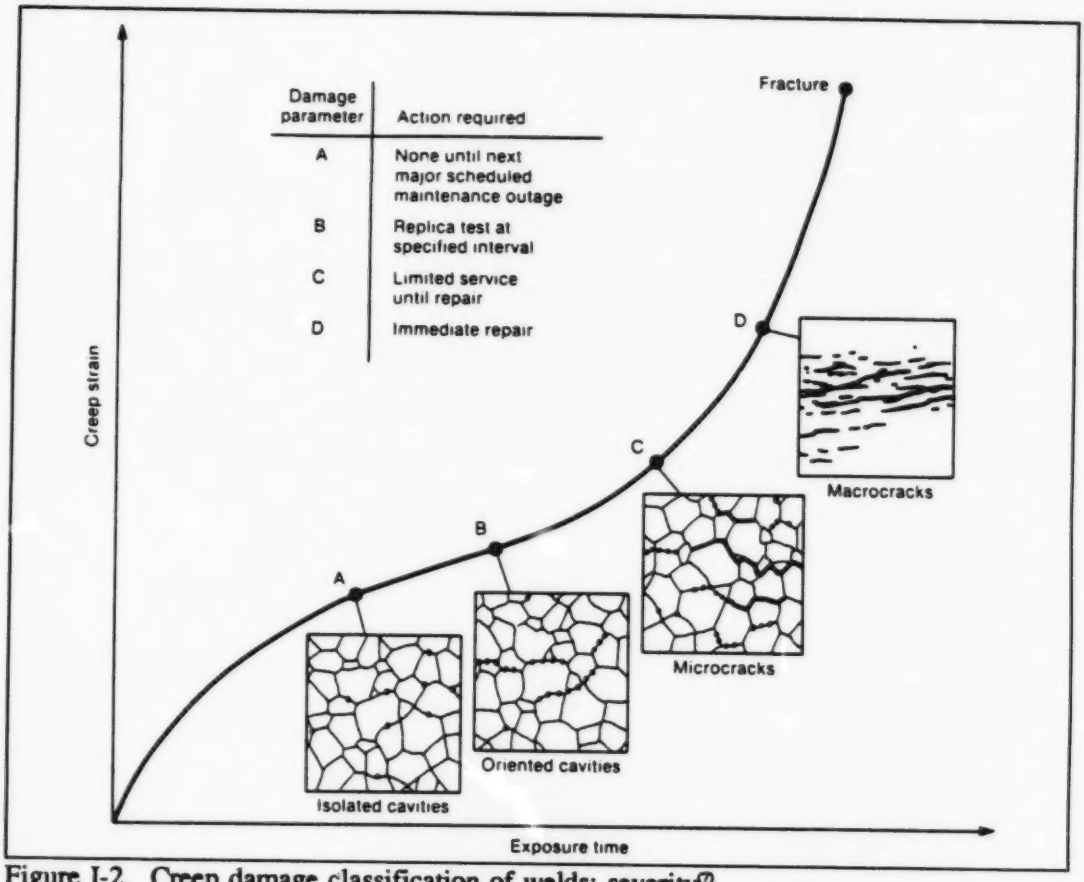

Figure I-2. Creep damage classification of welds; severity[7].

APPENDIX II

SUMMARY OF REPLICA RESULTS

LAKEVIEW UNITS 5 & 6 TURBINE/LOOP PIPE REPLICA INSPECTION

WELD	LOCATION	RESULTS
Unit 5 Jt - 5TLL1 Replica - 75 **(filed under U5 Main Steam)**	East Loop Pipe Terminal Weld to G.I.E.S./G.V. (south side of turbine)	- 10 cm crack oriented circumferentially in steam chest HAZ on south side of pipe was found by MPI. - one replica was taken on this area revealing severe type IV level D throughout intercritical region - action: GEC/HOWDEN to repair weld with spool piece (OHRD to evaluate spool)
Unit 5 Jt - 5BLR1 Replica - 74 **(filed under U5 Main Steam)**	West Loop Pipe Terminal Weld to G.I.E.S./G.V. (south side of turbine)	- 10 cm crack oriented circumferentially in steam chest HAZ on south side of pipe was found by MPI - one replica was taken on this area revealing severe type IV & I level D - action: GEC/HOWDEN to repair weld, weld root replica shows no creep damage.
Unit 5 Jt - 5TLR1 Replicas - 1/2	East Loop Pipe Terminal Weld to Steam Chest (north side of Turbine)	- 2 replicas taken revealing extremely isolated type IV level A at both North & South locations in S.C. HAZ. Isolated Type III level C and extremely isolated Type IV level A in pipe HAZ at south replica loc'n - action: GEC/HOWDEN to repair weld.

LAKEVIEW UNITS 5 & 6 TURBINE/LOOP PIPE REPLICA INSPECTION

WELD	LOCATION	RESULTS
Unit 5 Jt - 5BLL1 Replicas - 3/4	West Loop Pipe Terminal Weld to Steam Chest (north side of Turbine)	- 2 replicas taken revealing a dense distribution of Type IV level A/B in S.C. HAZ at the North rep. loc'n and extremely isolated Type IV level A at South rep. loc'n in S.C.. Dense Type III level C and isolated Type IV A found in pipe HAZ at south rep. loc'n. - action: GEC/HOWDEN to repair weld
Unit 5 Jt - 5TLL5 Replicas - 11/12 68/69	H.P. Upper Loop Pipe Terminal Weld to Turbine (south side of Turbine)	- 2 replicas taken revealing a dense distribution of Type III C and Type IV level B/A in Flange HAZ in entire OD (extrados) loc'n. ID (intrados) loc'n has isolated Type III B and less dense Type IV A in Flange HAZ. - action: GEC/HOWDEN to repair weld, root replica shows no creep damage.
Unit 5 Jt - 5TLR5 Replicas - 31/32	H.P. Upper Loop Pipe Terminal Weld to Turbine (north side of Turbine)	- 2 replicas taken revealing Type IV level A along the entire O.D. replica site in the Flange HAZ. No creep damage was found at the I.D. replica location. - action: GEC/HOWDEN to repair weld, root replica shows no creep damage.

LAKEVIEW UNITS 5 & 6 TURBINE/LOOP PIPE REPLICA INSPECTION

WELD	LOCATION	RESULTS
Unit 5 Jt - 5HPM6 Replicas - 15/16	H.P., West 'Y' piece to Steam Chest (south side of Turbine)	- 2 replicas taken at Top and West loc'ns no damage was found. - action: recommend regular inspection intervals as Unit 6 equivalent weld had serious creep damage.
Unit 5 Jt - 5HPM7 Replicas - 17/18	H.P., East 'Y' piece to Steam Chest (south side of Turbine) action: recommend regular inspection as serious creep damage exists in Unit 6 equiv.	- 2 replicas taken revealing isolated Type III B and very isolated Type IV A in S.C. HAZ at Top replica loc'n. East loc'n contained very isolated Type IV A at the south end of the replica in the S.C. HAZ. 5 mm & 3 mm circumferential cracks were also found in the C.G. 'Y' piece HAZ though they are not creep rel.
Unit 5 Jt - 5BLR10 Replicas - 5/6	I.P. Loop Pipe to Reheat Steam Chest (North side of Turbine 'FW 1')	- 2 replicas taken revealing no creep damage although all replicas displayed holes/tears at G.B's throughout entire replicas. - action: weld is okay

LAKEVIEW UNITS 5 & 6 TURBINE/LOOP PIPE REPLICA INSPECTION

WELD	LOCATION	RESULTS
Unit 5 Jt - 5TLL10 Replicas - 7/8	I.P. Loop Pipe to Reheat Steam Chest (North side of Turbine 'FW 2')	- 2 replicas taken revealing possible very isolated Type IV A near weld repair in pipe HAZ at Top replica loc'n. East replica loc'n revealed no creep damage. - action: weld is okay
Unit 5 Jt- 5HPM1 Replicas - 9/10	H.P., Cross Under Pipe to Steam Chest (North side of Turbine)	- 2 replicas taken revealing isolated Type III C and extremely isolated Type IV A in S.C. HAZ at Top Loc'n. Some Type III B in pipe HAZ at both replica loc'ns. SEM showed most optical Type IV indications were in fact holes/tears. - action: weld is okay
Unit 5 Jt - 5BLL10 Replicas - 23/24	I.P. Loop Pipe to Reheat Steam Chest (South side of Turbine 'FW1')	- 2 replicas taken revealing isolated Type III B in pipe HAZ plus many holes in replica in FG S.C. HAZ at Top replica loc'n. East replica displayed no damage. - action: weld is okay, although a future reinspection is recommended.

LAKEVIEW UNITS 5 & 6 TURBINE/LOOP PIPE REPLICA INSPECTION

WELD	LOCATION	RESULTS
Unit 5 Jt - 5TLR10 Replicas - 21/22	I.P. Loop Pipe to Reheat Steam Chest (South side of Turbine 'FW2')	- 2 replicas taken revealing many holes in replica in FG S.C. HAZ at both replica loc'ns. No damage was found in the pipe HAZ at either replica loc'n. - action: weld is okay, although future reinspection is recommended.
Unit 5 Jt - 5TLL15 Replicas - 29/30	I.P. Loop Pipe butt weld near top of Turbine (South side of Turbine)	- 2 replicas taken revealing no creep damage, although many carbides at G.B.s in casing HAZ were noted at ID replica location. - action: weld is okay
Unit 5 Jt - 5TLL16 Replicas - 27/28	I.P. Loop Pipe butt weld to turbine casing (south side of turbine)	- 2 replicas taken revealing no creep damage, although many carbides at G.B.s in casing HAZ were noted at ID replica location - action: weld is okay

LAKEVIEW UNITS 5 & 6 TURBINE/LOOP PIPE REPLICA INSPECTION

WELD	LOCATION	RESULTS
Unit 5 Jt - 5TLR16 Replicas - 70/71	Upper I.P. Loop Pipe butt weld near top of turbine casing (North side of Turbine)	- 2 replicas taken revealing no creep damage. However at the ID location in the pipe closest to the turbine several circumferential 0.5 mm fabricat. defects were found in the parent metal. At the OD loc'n several longitudinal stringers were found in the same pipe. - action: weld is okay.
Unit 5 Jt - 5TLR17 Replicas - 72/73	Upper I.P. Loop Pipe terminal weld to top of turbine casing (North side of Turbine)	- 2 replicas taken revealing no creep damage. ID location has same circum. fabrication defects in PM extending for 30 mm in same pipe shared by 5TLR16. OD loc'n also has same longitudinal stringer in same pipe as 5TLR16. - action: weld is okay.
Unit 5 Jt - 5IPM1 Replicas - 73, 73.A & 73.B **(filed under U5 Main Steam rep's)**	East Reheat Intercept Pipe to North Reheat Steam Chest Weld	- 1 replica plus 2 repeat replicas taken to confirm findings. Weld has dense Type III C & Type IV A at the Bot. loc'n in the intercept pipe HAZ. - action: GEC/HOWDEN to repair weld.

LAKEVIEW UNITS 5 & 6 TURBINE/LOOP PIPE REPLICA INSPECTION

WELD	LOCATION	RESULTS
Unit 6 Jt - 6TLL1 Replicas - 39,40 64	H.P. West Loop Pipe Terminal Weld to Steam Chest (North side of Turbine)	- 3 replicas taken revealing Type III A/B in initial two replicas. Repeat replica on NORTH location revealed III A/B and very isolated IV A in Pipe HAZ, no creep damage was found in S.C. HAZ after SEM examination. - action: weld is okay provided it is inspected yearly.
Unit 6 Jt - 6BLR1 Replicas - 43,44 63	H.P. East Loop Pipe Terminal Weld to Steam Chest (North side of Turbine)	- 2 replicas taken revealing extremely isolated Type IV A indications in SC HAZ at South replica loc'n. A repeat replica plus SEM exam reveals no creep damage. - action: weld is okay.
Unit 6 Jt - 6TLR1 Replicas - 41,42 66	H.P. West Loop Pipe Terminal Weld to G.I.E.S./G.V. (South side of Turbine)	- 2 replicas taken revealing extremely isolated Type IV A indications in pipe HAZ at both locations and SC HAZ at North Loc'n. A repeat replica at SOUTH loc'n reveals no creep damage after SEM examination. - action: weld is okay.

LAKEVIEW UNITS 5 & 6 TURBINE/LOOP PIPE REPLICA INSPECTION

WELD	LOCATION	RESULTS
Unit 6 Jt - 6BLL1 Replicas - 47,48 65	H.P. East Loop Pipe Terminal Weld to G.I.E.S./G.V. (South side of Turbine)	- 2 replicas taken revealing confirmed Type IV A (low density) & III B in SC HAZ at North Loc'n. Repeat replica taken at SOUTH loc'n revealing confirmed Type IV A in SC HAZ (by SEM). - action: GEC/HOWDEN to repair weld, root replica shows no creep damage.
Unit 6 Jt- 6TLL5 Replicas - 19/20	H.P. Upper Loop Pipe Terminal Weld to Turbine (North side of Turbine)	- 2 replicas taken revealing isolated III B/C and a dense patch of IV A for 1/3 of OD site in Flange HAZ. ID site has isolated III B/C and isolated IV A. - action: GEC/HOWDEN to repair weld, root replica shows no creep damage.
Unit 6 Jt - 6TLR5 Replicas - 33/34	H.P. Upper Loop Pipe Terminal Weld to Turbine (South side of Turbine)	- 2 replicas taken revealing dense III B/C and less dense IV A throughout OD loc'n in Flange HAZ. ID site has isolated IV A in Flange HAZ also. - action: GEC/HOWDEN to repair weld, root replica shows no creep damage.

LAKEVIEW UNITS 5 & 6 TURBINE/LOOP PIPE REPLICA INSPECTION

WELD	LOCATION	RESULTS
Unit 6 Jt - 6BLL3 Replica - 49	H.P. Lower Loop Pipe Terminal Weld to Turbine (North side of Turbine)	- 1 area replicated/macro etch to see if old HAZ had been entirely removed when new weld was put in: Old HAZ appears to have been removed no creep damage was found.
Unit 6 Jt - 6HPM5 Replicas - 50,51 67	H.P., East Leg of 'Y' piece to Steam Chest (south side of Turbine)	- 3 areas replicated revealing severe Type IV C/B and level A/B in shop weld repair area. Shop repair extends 180 and 10 cm into 'Y' side. Creep damage was found. throughout the repair area. - action: a spool piece repair was strongly recommended to GEC/HOWDEN.
Unit 6 Jt - 6HPM4 Replicas - 52/53	H.P., West Leg of 'Y' piece to Steam Chest (south side of Turbine)	- 2 areas replicated revealing Type III & IV A along weld repair in 'Y' HAZ on top location. Type III A/B to one side and Type IV A in entire replica were found 'Y' HAZ at East Loc'n. Weld repair is same size and location as East Leg. - action: a spool piece repair was strongly recommended to GEC/HOWDEN.

LAKEVIEW UNITS 5 & 6 TURBINE/LOOP PIPE REPLICA INSPECTION

WELD	LOCATION	RESULTS
Unit 6 Jt - 6HPM1 Replicas - 45/46	I.P., Cross Under Pipe to Steam Chest (North Side of Turbine)	- 2 replicas taken revealing isolated Type III B/C and isolated IV A at both replica locations in SC HAZ. Pipe HAZ showed no damage at either replica site. - action: suspect Type IV indications are holes, therefore replica is okay.
Unit 6 Jt - 6TLR16 Replicas - 13/14	I.P. Loop Pipe butt weld near top of Turbine (South side of Turbine)	- 2 replicas taken no creep damage was found. - action: weld is okay
Unit 6 Jt - 6TLL14 Replicas - 25/26	I.P. Loop Pipe butt weld near top of Turbine (North side of Turbine)	- 2 replicas taken possible isolated Type IV A in 6TLL13 (LEFT) HAZ at OD loc'n. No creep damage found in other areas. - action: weld is okay, Type IV indications are holes/tears in replica.

LAKEVIEW UNITS 5 & 6 TURBINE/LOOP PIPE REPLICA INSPECTION

WELD	LOCATION	RESULTS
Unit 6 Jt - 6TLL15 Replicas - 37/38	I.P. Loop Pipe Terminal weld to I.P. Turbine Casing (North side of Turbine)	- 2 replicas taken, no Type IV damage found. O.D. replica has possible III A in pipe (left) HAZ, while I.D. loc'n has 0.5 mm crack in weld metal. - action: weld is okay.
Unit 6 Jt - 6TLR17 Replicas - 35/36	I.P. Loop Pipe Terminal weld to I.P. Turbine Casing (South side of Turbine)	- 2 replicas taken, I.D. loc'n has possible isolated IV A in Flange (right) HAZ and a circumferentially oriented parent metal grain structure in pipe side. O.D. loc'n revealed no damage. - action: weld is okay, though future reinspection is recommended.
Unit 6 Jt - 6BLL10 Replicas - 54/55	I.P. Loop Pipe Terminal Weld to Reheat Steam Chest (North side of Turbine)	- 2 replicas taken, some isolated III A in SC HAZ at East loc'n, all other areas okay. - action: weld is okay.

LAKEVIEW UNITS 5 & 6 TURBINE/LOOP PIPE REPLICA INSPECTION

WELD	LOCATION	RESULTS
Unit 6 Jt - 6TLR10 Replicas - 56/57	I.P. Loop Pipe Terminal weld to Reheat Steam Chest (North Side of Turbine)	- 2 replicas taken, East Loc'n has possible isolated III A and very isolated IV A, all other areas okay - action: weld is okay.
Unit 6 Jt - 6BLR10 Replicas - 58/59	I.P. Loop Pipe Terminal weld to Reheat Steam Chest (South Side of Turbine)	- 2 replicas taken, all areas revealed no creep damage. - action: weld is okay.
Unit 6 Jt - 6TLL10 Replicas - 60/61	I.P. Loop Pipe Terminal weld to Reheat Steam Chest (South Side of Turbine)	- 2 replicas taken, all areas revealed no creep damage. - action: weld is okay.

APPENDIX III

MAGNETIC PARTICLE INSPECTION REPORTS

HOWDEN CANADA
INSPECTION RECORD SHEET

CLIENT/SITE:	RECIRCULATION	JOB # 5945	SHT # 5-92
COMPONENT:	HP LOOP PIPE WELDS	CONT. # 1136	PAGE #
DWG. NO:		C/N #	TEST DATE: 23-8-90

AS STRIPPED DOWN ✓ STRIP DOWN INSPECTION REPORT AS REBUILT

MPI examination of the following two HP Loop joints (old welds) reveal approx 4" long cracks in the Heat affected Zone of the weld on the chest side. Both cracks do not appear to have much depth.

Joint: 5 BLR 1

: 5 TLL 1.

ISSUER: SIGNATURE [signature] DATE: 23/8/90 QUALITY CONTROL SIGNATURE [signature] DATE: 23/8/90

GEC DISPOSITION

HOWDEN CANADA
INSPECTION RECORD SHEET

CLIENT/SITE:	GEC/LAKEVIEW	R/C # 5946	SHT # 44.1-702
COMPONENT:	HP. MANIFOLD WELD	CONT. # 1136	PAGE # 1 of
~~WELD~~ SHE NO:	6 HPM 4 (WEST SIDE)	C/A #	TEST DATE: OCT 19 90

AS STRIPPED DOWN ✓ | MAGNETIC PARTICLE INSPECTION | AS REBUILT

A. MAG. ARTICLE METHOD:

1. M.T. PROCEDURE: C-3190. 2. OP. NO: N/A.
3. CURRENT: AC _____. DC _____. HW RECTIFIED ✓.
   VALUE 800 AMPERES.
4. MAGNETISED BY: YOKE _____. TYPE _____.
   PRODS ✓. SPACING 8".
   CENTRAL CONDUCTOR _____.
   COILS _____. TURNS _____.
5. WET MEDIUM: VISIBLE BLACK INK. FLUORESCENT _____.

B. COMPONENT:

6. CASTING _____. 7. FORGING _____.
8. WELD: I.D: _____.
   (a) WELD PREP _____. (b) ROOT _____. (c) FIN WELD ✓.
9. OTHERS (SPECIFY) _____

C. RECORDABLE INDICATION/REMARKS.

TEST PERFORMED ON WELD # 6 HPM 4 REVEALED 3 CRACK INDICATIONS LOCATED AS FOLLOW:

#1 - 6" FROM UT #2	2" FROM WELD, OPPOSITE CHEST	1/4" LONG
#2 - 1½" FROM UT #3	IN WELD (LONGITUDINAL)	1/4" LONG
#3 - 3" FROM UT #3	2½" FROM WELD, CHEST SIDE	1/4" LONG

ISSUER: SIGNATURE	DATE: OCT 19 90	QUALITY CONTROL SIGNATURE	DATE: 20/11/90
GEC SIG: DATE:	CH SIG: DATE:	MCCR SIG: DATE:	

HOWDEN CANADA
INSPECTION RECORD SHEET

CLIENT/SITE:	GEC/LAKEVIEW	W/C # 5946	SHT # 44.1-702
COMPONENT:	H.P MANIFOLD WELD	CONT. # 1136	PAGE # 14
WELD NO:	6 HPM 5 (EAST SIDE)	C/A #	TEST DATE: OCT # 91

AS STRIPPED DOWN ✓ | MAGNETIC PARTICLE INSPECTION | AS REBUILT

A. MAG. ARTICLE METHOD:

1. N.T. PROCEDURE: C-3196. 2. OP. NO: N/A.
3. CURRENT: AC _____. DC _____. HW RECTIFIED ✓.
   VALUE 800 AMPERES.
4. MAGNETISED BY: YOKE _____. TYPE _____.
   PRODS ✓. SPACING 8"
   CENTRAL CONDUCTOR _____.
   COILS _____. TURNS _____.
5. WET MEDIUM: VISIBLE BLACK INK. FLUORESCENT _____.

B. COMPONENT:

6. CASTING _____. 7. FORGING _____.
8. WELD: I.D: _____.
   (a) WELD PREP _____. (b) ROOT _____. (c) FIN WELD ✓.
9. OTHERS (SPECIFY) _____

C. RECORDABLE INDICATION/REMARKS.

TEST PERFORMED ON WELD # 6 HPM 5 REVEALED 7 CRACK INDICATIONS LOCATED AS FOLLOW:

#1 - 3" FROM U.T. #1	1" FROM WELD, OPPOSITE CHEST	1/4" LONG
#2 - 4 1/2" FROM UT #1	1" FROM WELD, OPPOSITE CHEST	3/8" LONG
#3 - 5" FROM U.T. #1	1" FROM WELD, OPPOSITE CHEST	1" LONG
#4 - 2" FROM UT # 2	IN WELDED AREA (LONGITUDINAL)	1/4" LONG
#5 - 5 1/2" FROM UT # 2	3" FROM WELD, OPPOSITE CHEST	1/4" LONG
#6 - 1" FROM UT # 3	IN WELD (LONGITUDINAL)	1 1/2" LONG
#7 - 2" FROM UT # 1	2" FROM WELD, CHEST SIDE	1" LONG

ISSUER: SIGNATURE	DATE: OCT 19 '90	QUALITY CONTROL SIGNATURE	DATE: 29/10/91
GEC SIG: DATE:	CM SIG: DATE:	NCCR SIG: DATE:	